9.1 ALTERNATIVE POST-INJECTION SITE CARE TIMEFRAME 40 CFR 146.93(a)

MARQUIS BIOCARBON PROJECT

Facility Information

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Well name:	MCI CCS 3
Well location:	PUTNAM COUNTY, ILLINOIS Non Responsive -- Geological information [redacted]

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9.1 <u>Alternative Post-Injection Site Care and Site Closure (PISC) Plan</u>

Marquis Carbon Injection LLC will conduct post-injection monitoring for a five-year period following the cessation of injection operations. A justification for this alternative PISC timeframe is provided below.

9.1.1 Computational Modeling Results – 40 CFR 146.93(c)(1)(i)

Figure 9-3 in the PISC and Site Closure Plan (Permit Section 9) shows the cross section of the predicted CO_2 plume extent and demonstrates the CO_2 plume stability during alternative PISC timeframe. Figure 9-4 in the PISC and Site Closure Plan (Permit Section 9) illustrates a cross section of the predicted pressure front during the post-injection period. The pressure front declines quickly during the post-injection period. Figure 9-1 in the PISC and Site Closure Plan (Permit Section 9) shows, the predicted pressure at the MCI CCS 3 well reaches pre-injection pressure in less than the proposed 5-year PISC timeframe. Given the fast CO_2 plume stabilization and rapid pressure decrease in the Mt. Simon Sandstone predicted by the computational modeling, a 5-year PISC is appropriate to ensure USDW protection.

This was further supported by a sensitivity analysis to test the effects of varying the porosity and permeability relationships on the CO_2 plume shape and pressure behavior (Figures 9-1 and 9-2). High side and low side case runs, testing two porosity permeability relationships in addition to the base case were performed. The permeability vs porosity plot for each case in the Mt Simon is shown Figure 9-1. The results of the sensitivity analysis indicate that the CO_2 plume shape is similar in both cases compared to the base case scenario (Figure 9-2). Details related to this sensitivity analysis are discussed further in AoR and Corrective Action Plan Section (Permit Section 2.6.7).

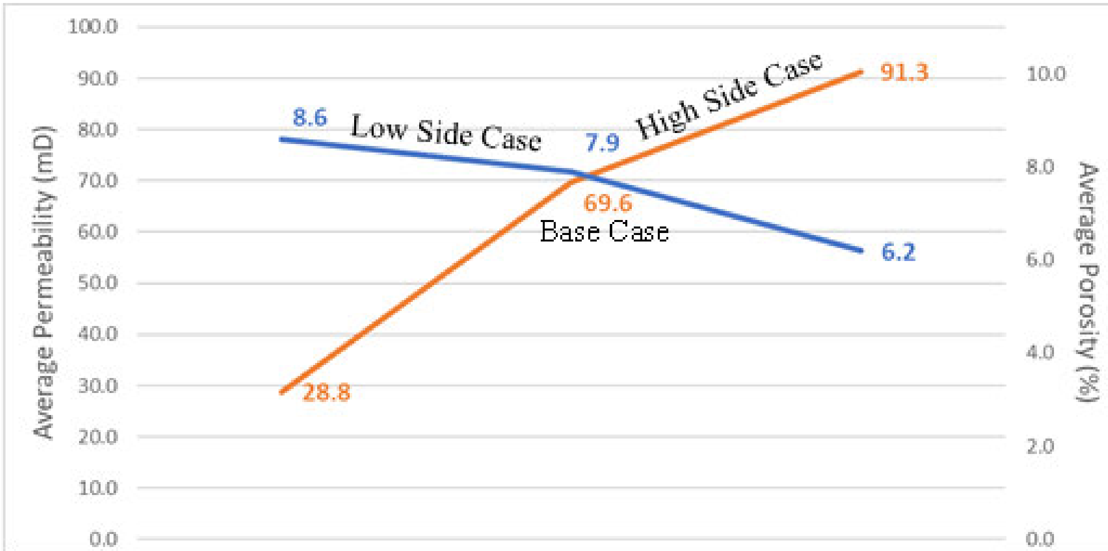

Figure 9-1: Plot of porosity and permeability relationships for High Side Case (orange line) and Low Side Case (blue line). The numbers on the orange are permeability values, number on the blue line are porosity values. The porosity permeability relationship for the base case was calculated from the ratio between permeability and porosity at the intersection of the curves.

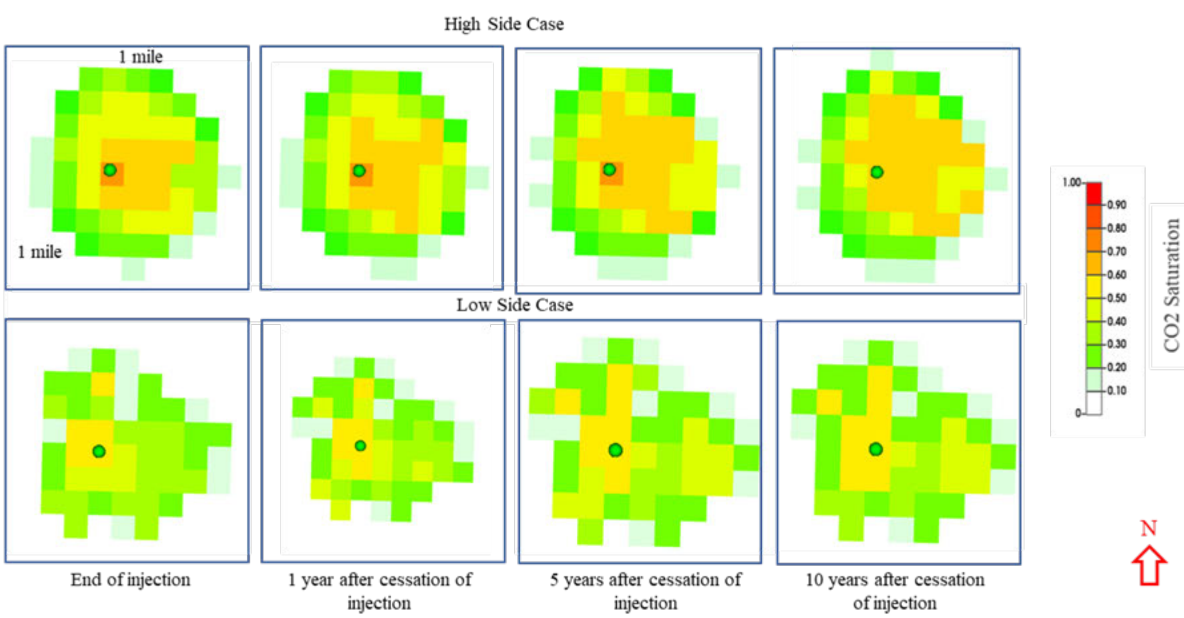

Figure 9-2: CO_2 plume at layer 153 (used to delineate AoR) at the end of injection, 1, 5 and 10 years after injection stopped for the High Side Case (top row) and Low Side Case (bottom row).

9.1.2 Predicted Timeframe for Pressure Decline – 40 CFR 146.93(c)(1)(ii)

Figure 9-4 in the PISC and Site Closure Plan (Permit Section 9) shows the cross section of the pressure front during the post injection phase. Additional plots and figures, showing the pressure front during the injection period, can be found in the AoR and Corrective Action Plan Section (Permit Section 2). The maximum spatial extent of the pressure front occurs at the end of the injection period. Figure 9-1 shows the predicted pressure buildup and decline at the MCI CCS 3 well through the injection phase and for 50 years of the post-injection period. The pressure declines immediately following cessation of injection and is predicted to be heterogenous between the MCI CCS 3 and MCI MW 2 wells. The details related to sensitivity analysis can be found in the AoR and Corrective Action Plan Section (Permit Section 2). A comparison of the pressure time series from the sensitivity analysis demonstrates that the pressure buildup during the injection phase and rapid decline during the PISC phase are similar to the base case scenario for different porosity permeability relationships.

Continuous pressure measurements will be acquired from the Mt. Simon Sandstone through the injection and PISC phases of the project (Testing and Monitoring Plan, Permit Section 7). The pressure data obtained during the injection phase of the project will be used to update the computational modelling every six months as per the reporting requirements in 40 CFR 146.91. Pressure data acquired during the PISC phase of the project are expected to verify the rapid decline in pressure in the Mt. Simon Sandstone predicted by the computational modelling.

9.1.3 Predicted Rate of Plume Migration – 40 CFR 146.93(c)(1)(iii)

Figure 9-2 shows the cross section of the CO_2 plume remains relatively stable from the end of the injection period to Year 3 and Year 5 of the PISC phase. Additional figures illustrating the predicted CO_2 plume expansion during the injection period are provided in the AoR and Corrective Action Plan Section (Permit Section 2.0). The average CO_2 plume extent was utilized to define the AoR. The details related to sensitivity analysis are presented in the AoR and Corrective Action Plan Section (Permit Section 2.6.7). The results from the sensitivity analysis show that the CO_2 plume shape remains a similar or smaller size and shape for the different modeled porosity permeability relationships (Figure 9-7).

9.1.4 Confining Zone Characterization – 40 CFR 146.93(c)(1)(vii)

The Eau Claire Formation is the primary confining unit for the project. The base of the Eau Claire Formation is comprised of the sandy Elmhurst Member where some CO_2 mobility is expected over time. However, the Eau Claire Formation has known thick and continuous shale intervals (Eau Claire Shale) above the Elmhurst Member, which have been confirmed as having good sealing capacity with core analysis (Permit Section 5). The Pre-Operational Testing Plan details the characterization that has been completed for the Eau Claire Shale (Permit Section 5.0). This included assessing the mineralogy, geomechanics, and capillary pressure within the Eau Claire Shale.

The properties of the Eau Claire Formation were distributed within a static reservoir model and then imported into the computational model. Figure 9-3 shows the cross section of the plume map at the end of the injection period and for Years 3 and 5 of the PISC phase. Additional figures illustrating the CO_2 plume behavior during a 50-year post-injection period have been included in the AoR and Corrective Action Plan Section (Permit Section 2.0). Computational modeling results show that there would be no CO_2 penetration into the Eau Claire Shale during the injection and post-injection modeling period due to the low permeability of the Eau Claire Shale.

9.1.5 Assessment of Fluid Movement Potential – 40 CFR 146.93(c)(1)(viii)-(ix)

There is no evidence of geological conduits within the AoR. Also, within the AoR there are no existing wells that penetrate either the injection zone or the confining layer, so no corrective action is required.

The MCI CCS 3 well will be constructed according to the USEPA Class VI regulations, and several measures will be incorporated in the well design to ensure protection of the USDWs at the site following the injection period (Injection Well Construction Plan, Permit Section 4). The long casing string and packer will be constructed of corrosion-resistant alloys (CR13) across the injection reservoir and confining zone to reduce the chances of casing degradation over the long term. Similarly, a CO_2-resistant cement will be pumped behind the deep string casing across the injection reservoir and confining zone. Following completion of the injection phase of the project and monitoring efforts, the MCI CCS 3 well will be plugged and abandoned according to the EPA Class VI guidelines, including the use of CO_2-resistant cement across the storage formation (Injection Well Plugging Plan, Permit Section 8).

During the injection and PISC phases of the project, the well integrity of the injection and MCI MW 2 well will be monitored through several internal and external monitoring techniques (Section 9.3, Permit Section 7.0). Annular pressures and fluid volumes will be monitored in the MCI CCS 3 well on a continuous basis until the MCI CCS 3 well is abandoned. Annular pressures in the MCI MW 2 well will be monitored daily. Temperature logging is the primary external mechanical integrity test that will be used to monitor the MCI CCS 3 and MCI MW 2 wells on an annual basis.

9.1.6 Location of USDWs – 40 CFR 146.93(c)(1)(x)

At the Marquis BioCarbon Project site, the Mt. Simon Sandstone is not considered a USDW based on salinity samples acquired from MCI MW 1 with total dissolved solids (TDS) concentrations greater than 10,000 milligrams per liter (mg/L) or 10,000 parts per million (ppm). The lowermost USDW is defined locally as the Gunter Sandstone of the Prairie du Chien Group (Knox Supergroup). At the MCI MW 1 well, the base of the Gunter Sandstone is 963 feet (ft) above the top of the Mt. Simon. USDWs in the project site range from the Gunter Sandstone (deepest USDW) to shallow, near-surface glacial till aquifers.

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